Press Release

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AI Model Developed by Brigham Researchers Could Help Screen for Heart Defect

An AI model has proven more efficient than traditional methods at detecting signs of atrial septal defect (ASD) in electrocardiograms (ECG).
Investigators from Brigham and Women's Hospital, a founding member of the Mass General Brigham healthcare system, and the Keio University School of Medicine in Japan have developed a deep learning artificial intelligence model to screen electrocardiograms (ECGs) for signs of atrial septal defects (ASD). This condition can cause heart failure and is underreported due to a lack of symptoms before irreversible complications arise. The results of this research have been published in *eClinicalMedicine*.

"If we can deploy our model on a population-level ECG screening, we would be able to identify many more of these patients before they sustain irreversible damage," explain Shinichi Goto and Yoshinori Katsumata, who are corresponding authors on the paper. Shinichi Goto, MD, PhD, is an instructor in the Division of Cardiovascular Medicine, Brigham and Women's Hospital and an instructor in the Division of General Internal Medicine & Family Medicine, Department of General and Acute Medicine, Tokai University School of Medicine. Yoshinori Katsumata, MD, PhD, is an instructor at the Institute for Integrated Sports Medicine, Keio University School of Medicine.

ASD is a common adult congenital heart disease caused by a hole in the heart's septum that lets blood flow between the left and right atriums. It is diagnosed in about 0.1% to 0.2% of the population but is likely underreported, Goto and Katsumata say. The symptoms of ASD are typically very mild or, in many cases, nonexistent until later in life. Symptoms include an inability to do strenuous exercise, changes in the rate or rhythm of the heartbeat, heart palpitations, and an increased risk of pneumonia.

Even without symptoms, ASD can stress the heart and increase the risk of atrial fibrillation, stroke, heart failure, and pulmonary hypertension. At that point, the complications of ASD are irreversible, even if the defect is fixed later. If found early, ASD can be corrected with minimally invasive surgery to improve life expectancy and reduce complications.

There are several ways to detect ASD. First, the largest defects can be found by listening to the heart with a stethoscope. But only about 30% of patients can be identified in this way. Another is by echocardiogram, a time and labor-intensive test that is not a good option for screening. Another test, electrocardiography, or ECG, takes only about a minute, making it usable as a screening tool. However, when humans analyze an ECG readout for known abnormalities associated with ASD, their ability to detect these abnormalities is limited.

To see if an AI model could better detect ASD from ECG readouts, the research team fed a deep learning model ECG data from 80,947 patients over the age of 18 who underwent both ECG and echocardiogram to detect ASD. Of these, a total of 857 patients were diagnosed with ASD. The data was collected from three hospitals: two large teaching institutions—one, Brigham and Women's

Hospital, in the US, and the other, the Keio University School of Medicine in Japan—as well as a community hospital, Dokkyo Medical University Saitama Medical Center in Japan. The model was then tested using scans from Dokkyo, which has a more general population and doesn't specifically screen patients for ASD. The model detected ASD 93.7% of the time, proving more sensitive than screening based on known ECG abnormalities, which identified ASD 80.6% of the time.

"It picked up much more than what an expert can identify using known abnormalities to identify cases of ASD," Goto and Katsumata say. One limitation of the study is that the model was trained using samples from academic institutions, which deal more with rare diseases like ASD. All the patients used to train the model were being screened for ASD and received an echocardiogram, so it is not clear how well the model would work on a general population, which is why the team tested it on the data from Dokkyo. "The model's performance was retained even in the community hospital's general population, which suggests that the model generalizes well."

The authors also note that even when using echocardiograms to detect ASD, they will not find every defect. Some could evade both the regular screening and the AI model, though these smaller defects are less likely to require surgical closure. “The problem with machine learning is that it's a black box — we don't really know what features it has identified,” Goto and Katsumata say. This means that the model cannot be used to learn about new features to look for in ECG results.

The results of this study suggest that the technology could be used in population-level screening to detect ASD before it leads to irreversible heart damage. ECG is relatively low-cost and currently performed in many contexts. “Perhaps this screening could be integrated into an annual PCP appointment or used to screen ECGs taken for other reasons,” Goto and Katsumata say.

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